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Discover Engineering

9 July 2015

Group 3: Water-those!!!!!!!

Water is a rapidly dwindling resource in the state of California. With only a year's worth of water left, people are more desperate than ever for a solution to the drought. One of the most efficient solutions for this issue is to create a waste treatment plant for storm runoff and greywater, so that the water can be made safe for use and then used for societal needs. This was the purpose of Group 3's project this week. For our water treatment plant, we used mostly the information we had learned during the first week from the Hyperion sewage treatment plant. The process of cleaning black water was more or less the same for our treatment of the grey water. Our plant design operates essentially like a smaller sewage treatment plan. One considerable factor is the size of the treatment plant. The plant needs to be large enough to operate at a safe capacity during the times that the area gets rainfall. However, it also needs a section of itself to run around the clock all year, to process the greywater from things such as sinks, washing machines, and other appliances. Since the Hyperion waste treatment plant has a daily flow of 362 million gallons, with a capacity of 450 million gallons (About Wastewater), and assuming that most water used for urban residential purposes is Greywater, the capacity for our plant would have to be at least around the same amount, at least for daily use. However, the plant will have to be far bigger than the

Hyperion waste treatment plant, in the event of rainfall. The maximum capacity would have to be situated to the amount of rain that the surrounding areas get per year. The storage of the water could be an issue as well. During periods of rain, the plant may end up with a large amount of excess water, as no one would need to use all that water at once. The most practical solution would be to store the water in a lake/reservoir, but that could potentially result poorly with the public, as someone's children will inevitably go for a swim in the random lake full of greywater. The most likely solution, then, is that there will be a large amount of water tanks located somewhere in the surrounding area, full of all the rainfall for the year, to be used for agriculture or civil needs. Moving on, the plant itself has several simple steps. The water intake would be filtered twice, chemically treated, biologically treated, and then treated with chlorine, which would make it somewhat safer to use and perhaps consume, and from there, would be pumped to a storage unit or pumped back into the surrounding cities to be used.

As mentioned before, the intake of hundreds of millions of gallons a day makes it essential that the plant be large in order to handle this vast amount of water. Water treatment plants cost an extravagant amount of money to build-- Hyperion, the water treatment plant we visited earlier in the program costed approximately 1.6 billion dollars to construct (Historical Development) -- and an extravagant amount of money to run, costing up to 1.3 million per day (Running Cost). When designing our treatment plant we had to take into consideration its efficiency in order to minimize the cost. One way we tried to minimize cost was to create and conserve energy as much as possible. In order to create energy, we would install turbines that spin as water flows downhill with

the force of gravity. These turbines would create hydropower that could provide a portion of the energy necessary to pressurize the water to pump in against the force of gravity back to the houses in the Los Angeles area.

The first step in our water treatment plant are the filtration systems. In the step, the water is rid of excess materials such as sand, dirt, and gravel and well as larger objects. Our filtration system has two parts-- the first part is the initial screening and the second is the Gravity chamber. In the initial screening large solid objects are removed. At hyperion we learned about the various objects that can be found in the water such as pipes, bowling balls, money, and even body parts. These heavier objects(sludge) sinks to the bottom of the tank and can be removed using a claw-like mechanism. Unlike blackwater, greywater does not come from sewage and therefore does not contain the human byproducts that could be used for methane to produce energy, so the plant's processes must mostly run from outside power. The second part of the system is the gravity chamber. In the gravity chamber water runs through layers of coal, gravel, and sand and the clean water accumulates at the bottom. The larger materials are located at the top of the chamber so that the waste is eliminated efficiently. The gravel is only there to support the system. Lastly, there will be a filter located at the output to prevent sand or other materials from getting through to the next purification stage.

From the filtration systems, the water is pumped to the chemical treatment area. This area is where the water will undergo the process of flocculation to cleanse out any undesirable molecular-sized particles. Flocculation is essentially causing particles and ions to coagulate into larger clumps called flocs, which can then be filtered out into

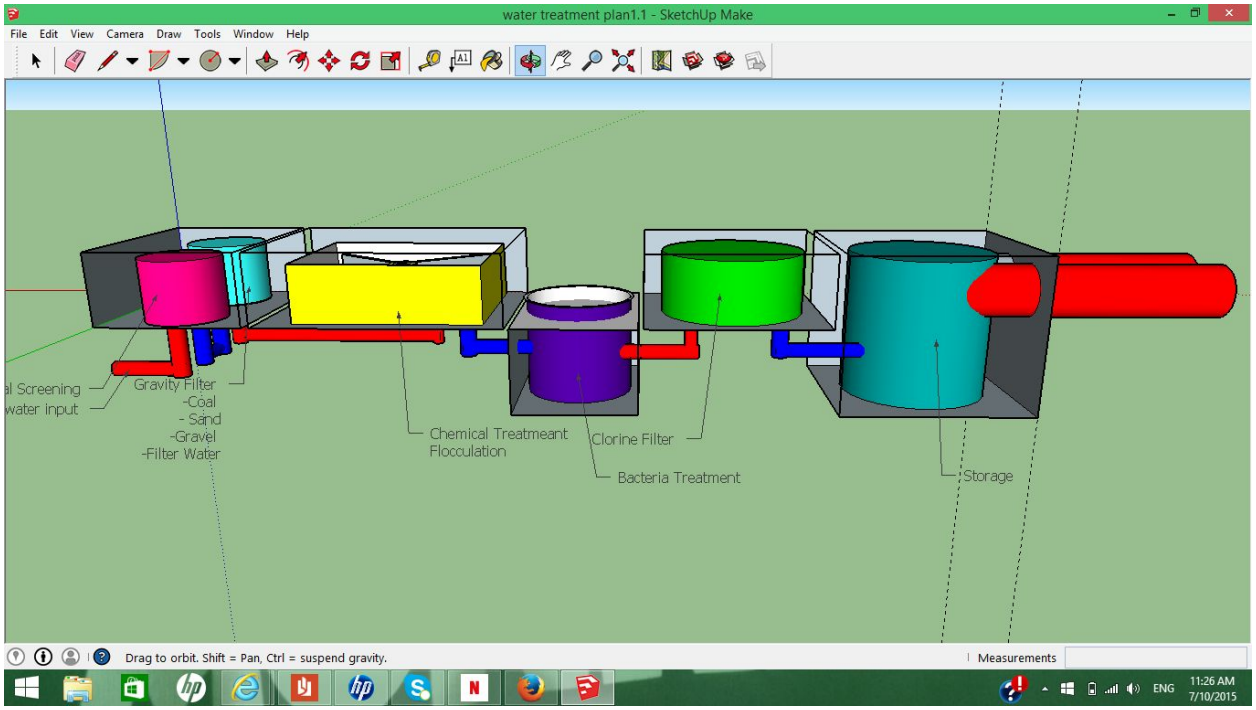
sludge to be sent away from the treatment plant. A coagulant such as Iron (III) Hydroxide [$Fe(OH)_3$], Aluminum Hydroxide [$Al(OH)_3$], or Ferric Chloride [$FeCl_3$] is added to the solution, causing the molecular-scale particles to coagulate into larger masses and drift to the bottom of the processing area (Flocculation). The sludge is then taken out of the bottom of the treatment area and disposed of.

From the chemical treatment, the water then moves to a biological treatment tank, where bacteria are mixed into the water, along with oxygen to help the bacteria colonize more rapidly. The bacteria consume any biological waste that might be in the water by feeding on them. The bacteria are then killed off in the step after that, which is to add chlorine to the water, killing the bacteria and making the water pretty much safe to consume.

The water then must be held in a storage tank until redistributed to the houses in the areas surrounding Los Angeles. The water traveled with the force of gravity when is came to the water treatment plant, but much travel against the force of gravity when returning to the residences. This process requires energy. We would use the energy we acquired through the turbines to power part of this process. To pump the water upwards to add pressure to force the water to move against the gravitational force. One issue, however, is that the energy produced from the turbines will most likely not be enough to power the pumping of water uphill to all the locations in Los Angeles. Thus, powering the distribution of the water will still be very costly.

The ramifications of using Greywater for civil use could be complicated, but very rewarding. There would have to be separate systems to separate blackwater inputs

from greywater inputs. The group also discussed having a separate system to deliver greywater as well as fresh water, for different uses in urban society. Greywater could be used for all sorts of things beyond just urban use. Central valley has one of the highest water usage rates in the world due to it's high agricultural output. If greywater could be used for the plants instead of fresh water, a massive amount of fresh water could be saved. Greywater could also be cheaper than fresh water, giving incentive for people to use it in the place of fresh water. The low pricing of the water could even lead to food being less expensive all around, which is beneficial to everyone. In all, having a greywater treatment plant to preserve water is pretty much essential in a state that is rapidly running out of water.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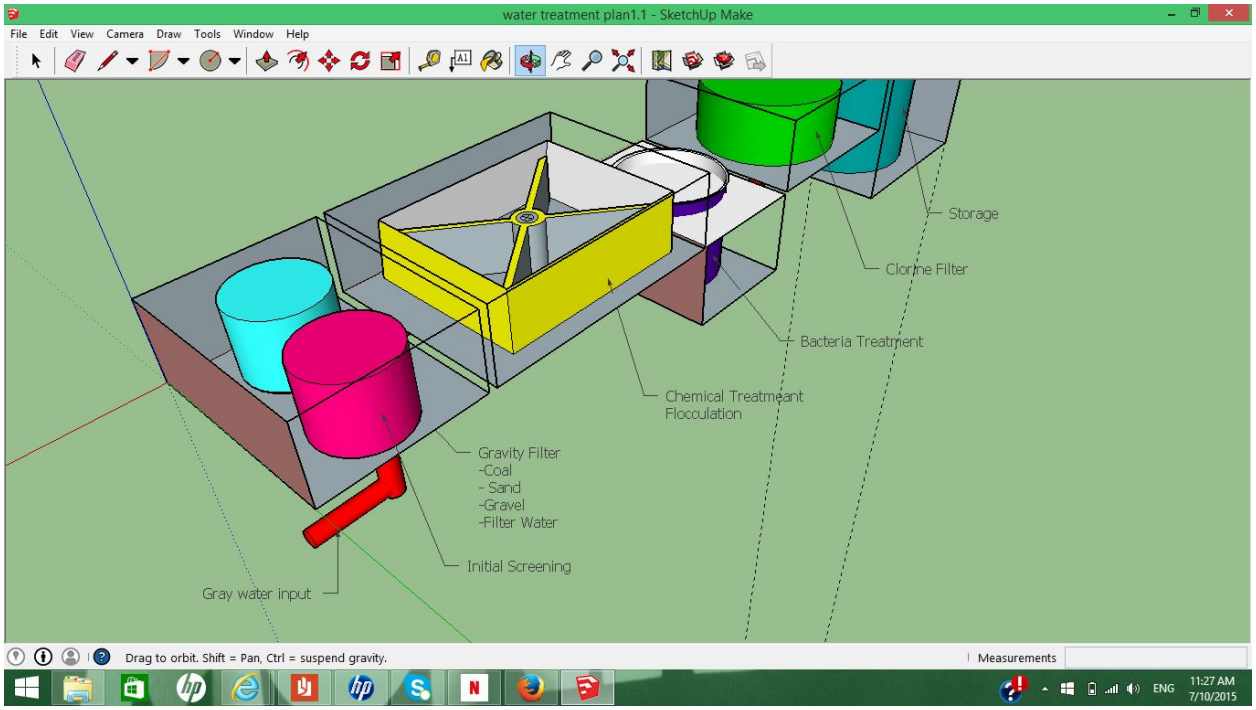
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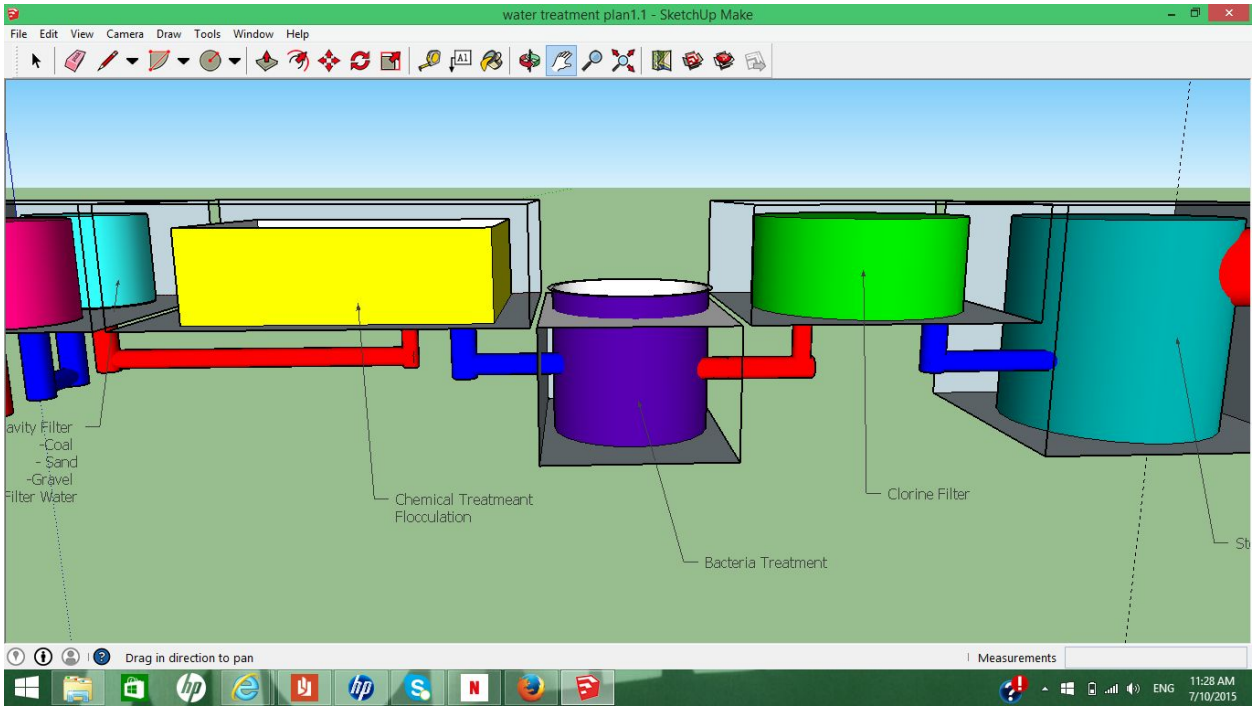
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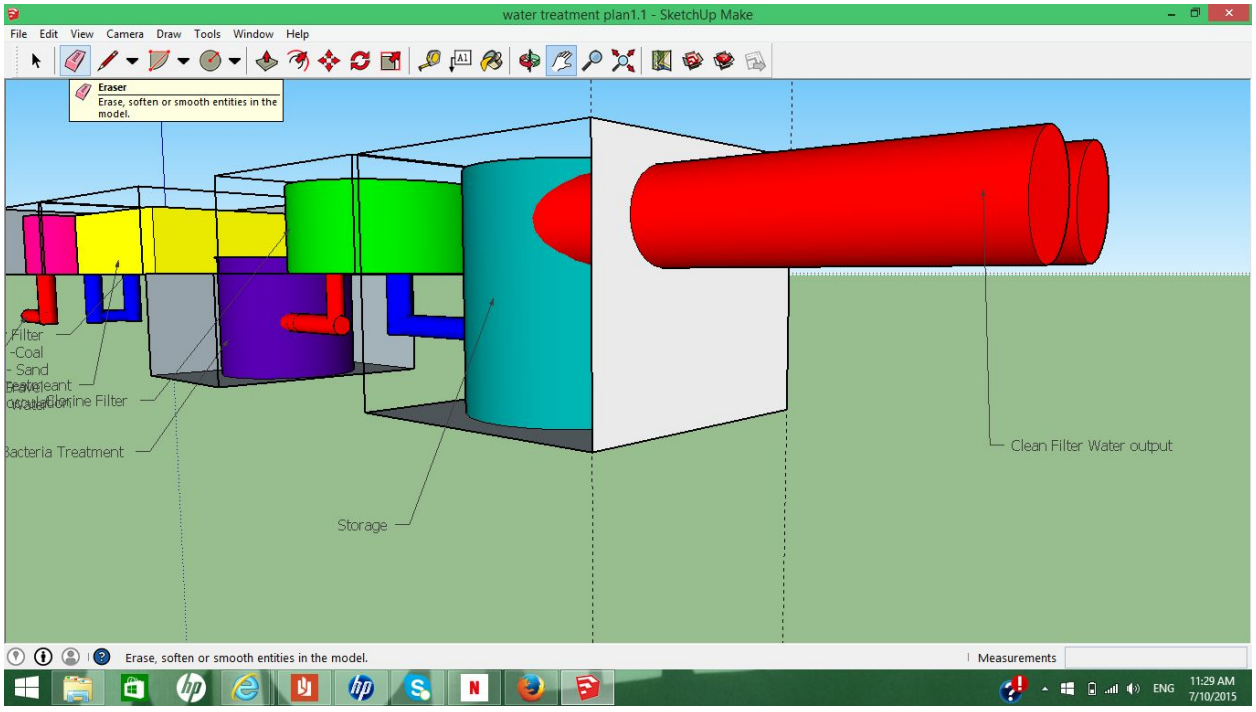
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Diagram of our water treatment plant

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